

## CLAIMS

What is claimed is:

1. A structure for responding to incoming radiation incident thereon, the structure comprising:
  - 5           a substrate having a diffractive surface;
  - a coating layer disposed over the diffractive surface, the coating layer having an index of refraction different from that of the substrate;
  - the diffractive surface comprising a relief pattern selected to diffract incident radiation with substantial efficiency into one or more diffraction orders
  - 10          other than the first order and to redirect the diffracted radiation from the structure in at least two directions at angles that are greater than a selected angle with respect to the surface normal.
2. The structure of Claim 1 wherein the diffracted directions are four
- 15          orthogonal directions.
3. The structure of Claim 1 wherein the diffractive surface is a diffractive optical element.
- 20          4. The structure of Claim 3 wherein the diffractive optical element is a binary diffractive optic.
5. The structure of Claim 3 wherein the diffractive optical element is a multilevel diffractive optic.
- 25          6. The structure of Claim 3 wherein the diffractive optical element is a kinoform.

7. The structure of Claim 3 wherein the diffractive optical element is a hologram.
8. The structure of Claim 1 wherein the substrate comprises a plastic film.
- 5 9. The structure of Claim 1 wherein the coating layer comprises a metallic layer.
- 10 10. The structure of Claim 1 further comprising an insulation layer disposed over the coating layer.
11. The structure of Claim 10 wherein the insulation layer comprises silicon oxide ( $\text{SiO}_2$ ).
- 15 12. The structure of Claim 10 wherein the insulation layer comprises aluminum oxide ( $\text{Al}_2\text{O}_3$ ).
13. The structure of Claim 10 wherein the insulation layer comprises a polymer.
- 20 14. The structure of Claim 10 wherein the insulation layer comprises magnesium fluoride ( $\text{MgF}_2$ ).
- 25 15. The structure of Claim 1 further comprising a transparent cover plate having a top surface disposed toward the incoming radiation and a bottom surface overlying the coating layer wherein incoming radiation incident thereon is propagated toward the diffractive surface and the selected angle is the critical angle for total internal reflection, the diffracted radiation is redirected from the diffractive surface toward the top surface of the transparent cover plate and internally reflected.

16. A solar cell module comprising:

a support structure having a planar surface;

5 a plurality of solar cells overlying the planar surface, the cells having front and back surfaces with the back surfaces facing the planar surface, the cells being spaced from one another, with predetermined areas of the planar surface free of solar cells;

a transparent cover member overlying and spaced from the solar cells having a top surface disposed toward incident radiation; and

10 a diffractive optical member overlying the predetermined areas of the planar surface, the diffractive optical member redirecting incident radiation toward the solar cells.

17. The solar cell module of Claim 16 wherein the diffractive optical member comprises:

a substrate having a diffractive surface;

a coating layer disposed over the diffractive surface, the coating layer having an index of refraction different from that of the substrate;

20 the diffractive surface comprising a relief pattern selected to diffract incident radiation with substantial efficiency into one or more diffraction orders other than the first order, the diffracted radiation redirected from the diffractive surface in at least two directions at angles that are greater than the critical angle for total internal reflection, toward the top surface of the transparent cover plate and internally reflected back toward the solar cells.

25 18. The solar cell module of claim 17 wherein the diffractive surface is embossed or molded to a depth less than the thickness of the substrate.

19. The solar cell module of claim 17 wherein the diffractive pattern comprises repeating unit cell structures having of lateral dimension of between 400 nanometers and 4000 nanometers.
- 5      20. The solar cell module of claim 17 wherein the diffractive optical member is disposed so that the diffractive pattern extends to cover the spaces between the solar cells.
- 10      21. The solar cell module of Claim 17 wherein the diffracted directions are two directions 180 degrees apart.
22. The solar cell module of Claim 17 wherein the diffracted directions are four essentially orthogonal directions.
- 15      23. The solar cell module of Claim 17 wherein the diffracted directions are six directions at least 20 degrees apart from one another.
24. The solar cell module of Claim 17 wherein the diffracted directions are eight directions at least 15 degrees apart from one another.
- 20      25. The solar cell module of Claim 17 wherein the diffractive surface is a diffractive optical element.
- 25      26. The solar cell module of Claim 25 wherein the diffractive optical element is a binary diffractive optic.
27. The solar cell module of Claim 25 wherein the diffractive optical element is a multilevel diffractive optic.

28. The solar cell module of Claim 25 wherein the diffractive optical element is a kinoform.
- 5 29. The solar cell module of Claim 25 wherein the diffractive optical element is a hologram.
30. The solar cell module of Claim 17 wherein the substrate comprises a plastic film.
- 10 31. The solar cell module of Claim 17 wherein the coating layer comprises a metallic layer.
32. The solar cell module of Claim 31 wherein the coating layer comprises aluminum or silver.
- 15 33. The solar cell module of Claim 17 further comprising an insulation layer disposed over the coating layer.
- 20 34. The solar cell module of Claim 33 wherein the insulation layer comprises silicon oxide ( $\text{SiO}_2$ ).
35. The solar cell module of Claim 33 wherein the insulation layer comprises aluminum oxide ( $\text{Al}_2\text{O}_3$ ).
- 25 36. The solar cell module of Claim 33 wherein the insulation layer comprises magnesium fluoride ( $\text{MgF}_2$ ).
- 30 37. The solar cell module of Claim 31 wherein the coating layer comprises a single dielectric coating.

38. The solar cell module of Claim 31 wherein the coating layer comprises a multilayer dielectric coating.

5 39. The solar cell module of Claim 16 wherein the solar cells and the diffractive optical member are encapsulated in a light transmissive polymer material that extends to and is bonded to the cover member and the planar surface of the support structure, with the light transmissive polymer being engaged with and bonded to the diffractive optical member.